

Atlantic Richfield Company

\$QWKRQ\| L 5◀ L %URZQ
3URMHW\| ODODJHU\| L OLOLQJ\|

! L &HQWHSRLOWH 'ULYH L
/D L 3DOPDQ L & \$ L !! L T +
211LFH L L ♂ L ↑ → □ L ↑ L +
)D[L L ♂ → ♀ L □ L L L ← +
(+ PDLO L SQWKRQ\◀ %URZQHES◀ FRPL

L
OV⁴ L / \QGD L 'HMFKOPEDXOWL
8⁴ 6⁴ L (3\$ L 5HJLRQL L
→ ↑ L +DZAKRUCH L 6NUHWL ♂ 6)' + → + ⊥ □ L
6DQ L)UDQFLVFRQ L & \$ L L + ¶ !! ↑ L

5(\perp /HYLDWKDQL ORQWKO \ \perp 5HSRUW \perp IRU \perp -XCH \perp \perp !! ¶ \rightarrow \perp DOQ \perp 6HFROQ \perp 4XDUWHU \perp \perp !! ¶ \rightarrow \perp 5, \perp)6 \perp 3

'HDUL 0V◀ L 'HMFKDPEDXOW L
L

7KH^L IROORZLQJ^L WHJW^L GHMFULEH^L DFLALYWLHV^L FRQGXFWHG^L GXULQJ^L WKH^L PRQWK^L RI^L -XQH^L ± !! ¶ → L DV
6LWHL^L & VLWH^L DQG^L DFLALYWLHV^L DQWLFLSDWHG^L WR^L RFFXU^L GXULQJ^L WKH^L XSFRPLQJ^L PRQWK^L L L 7KHMHL
EV^L ZRUN^L DUHD^L >\$VSHQL^L 6+HS^L &KDQHQD^L 8QGHUGUDLQ^L && '□^L DQG^L 'HOWD^L 6+HS^L & '6□@^L DQG^L VL
SURJUHW^L UHSRUW^L LVL^L EHLQJ^L VXEPLWHG^L LQ^L DFFRUGDQFH^L ZLWK^L 3DUDJUDSK^L ¶ ± L RI^L WKH^L \$GPLQL
\$JUHPHQW^L DQG^L 2UGHU^L RQ^L &RQMHQW^L IRU^L 5HPRYDO^L \$FVALRQ^L & \$2&□^L & H11HFVLYH^L -DQXDU\± ± ¶ ± ±
L

\$WODQWLFL 5LFKLHQL LVL DDMRL VXEPLWLQJL WKLVL CHWHL LQL VDWLVIDFWLRQL RI L WKHL TXDUWHU
UHTXLUHPHQW LHWL IRUWL LQL 3DUDJUDSKL T L RI L WKHL \$GPLQLWLDALYHL 2UGHUL IRUWL 5PHGLDO
)HMLELOWM L 6WKG\ L ♂ 5,↑)6□ L ♂ 86L (3\$ L 5HJLRQL ;@ L &(&/\$ L 'RFNHWL 1RK L ± !! !! ← + ¶ ← @ L -
7KH L TXDUWHU\ L VXPDU\ L RI L 5,↑)6L DFLYLWLHV L LV SURYLGHL DW WKHL HQG L RI L WKLVL CHWHL L

\$&7,9,7,(6^Л)25^Л-81(Л

\$VSHQ^L \oplus HS^L

x^L 2SHLDWHL WKHL \$VSHQL 6+HS%LRLUDFWRUL & \$6%□ L 7UHDWPHQWL 6\WHP L LQL UHFLUFXODWLRL PRG
PRQNL RI L -XQH L ZLNLK L WKHL H[FHSLWRQ L WKDW GLVFKDWH L WR L \$VSHQL &UHN L ZDL KDOWHGL RQL -XQH
VROLGV L PDQDJPHQWL DFWLYLWLHV ▲ L 7KH L UHFLUFXODWLRL V\WHP L DQGL HWDQRO L GRVLQJ L V\WHP L ZH
-XQH L ↗ ! q → L LQ SUHSUDWLRL WR GLDQL DQGL FCHDQL WKHL 3UWUHDWPHQWL 3RQG ▲ L 7KH
HWDQRO L GRVLQJ L UHXPHG L RQL -XQH L ↗ ! q → ▲ L 6RGLXP L K\GUR[LGH L GRVLQJ L ZDL QRW L QL
GLVFKDWH L WR L \$VSHQL &UHN L UHXPHG L RQL -XO L ↗ ! q → ▲ L L L

x⁻ : H H N O \ L U R W A L Q H \ L R S H U D W L R Q V \ L D Q G \ L P D L Q W H Q D Q F H \ L ♂ 2 0 □ \ L D F A W Y I W H V \ L Z H U H \ L F R Q G X F W H G \ L G X U L Q J \ L W - X Q H \ L ± !! ¶ → ◀ \ L

x^L 2Q^L -XQH^L ¶ + L DQG^L ¶ ↑ Ø L + !! ¶ → Ø L DQ^L HQKQFHG^L VDPSOLQJ^L HYHQW^L ZDV^L FROGXFWHG^L DC
FROGXFWHG^L TURPL WKH^L LQIOXHQW^L HI IOXHQW^L PDQKRQH^L + Ø L PDQKRQH^L + Ø L PDQKRQH^L + Ø L

/VQGD^L 'HMPKOPEDQW^L ± L 8⁴ 6⁴ L (3\$^L 5HJLRQ^L L
-XO\ L ¶ !! ☯ L ± !! ¶ → L
3DJH^L ± L RI^L L

ORFDWLQV^L IRUL ODERUDWRU\ L DQDO\VLV^L L 7KH^L FXWHQW^L DYDLODEOH^L ZDWHU^L TXDOLW^L GDWL^L IRUL
± !! ¶ → L VDPSOLQJ^L HYHQW^L DUH^L SUHMHQWGL^L LQ^L 7DEOH^L ¶ → L 5HFHQW^L LQIOXHQW^L IORZ^L UDWH^L SH^L
VXPPDUL]HG^L LQ^L 7DEOH^L ± L

x^L -XQH^L ¶ T ☯ L ± !! ¶ → L WKURXJK^L -XQH^L ± !! ☯ L ± !! ¶ → L VROLGV^L PDQDJHPHQW^L HTXLSPHQW^L ZDV^L GH^L
x^L 2Q^L -XQH^L ± !! ☯ L ± !! ¶ → L WKH^L VHWS^L RI^L VROLGV^L PDQDJHPHQW^L HTXLSPHQW^L ZDV^L FRPSCHWGL^L 2Q^L
± !! ☯ L ± !! ¶ → L DSSUR[LPDWHO\ L ¶ ↑ ☯ !! !! L JDOORQV^L VROLGV^L IURPL 3RQG^L ± L ZHHL SXPSHG^L
± !! ☯ L ± !! ¶ → L IORFFXODQW^L ZDV^L DGHG^L WR^L WKH^L VROLGV^L LQ^L WKH^L PL[L WDQN^L DOGL SXPSHG^L LQW^L
)LONUDWH^L IURPL WKH^L ELQV^L ZDV^L VARUHG^L ZLOO^L EH^L EURXJKW^L EDFN^L WR^L WKH^L \$6%^L 7UHDWPHQW^L 6\VVH^L
WUHDWPHQW^L L

x^L 2Q^L -XQH^L ± → ☯ L ± !! ¶ → ☯ L RSHUDWRU\ L REVHUYHG^L DL VPDQOOL CHDN^L ♂ DSSUR[LPDWHO\ L ↑ L P/PLC^L
GHZDWHULQJ^L ELQV^L RQWR^L WKH^L JURXQG^L L L ,PPHGLDWHO\ L DMHU^L WKH^L CHDN^L ZDV^L REVHUYHG^L DQOOL^L
IURPL WKH^L ELQ^L LQWR^L WKH^L PL[L WDQN^L \$WODQNLFL 5LFKI LHOG^L HWALPDWGL WKDW^L QR^L PRUH^L WKQQL^L
CHDNHG^L IURPL WKH^L ELQ^L L L 7KH^L ZHWHGL^L VRLO^L ZDV^L FRQNDLQHUL]HG^L DOGL VHFQGDU^L FRQNDLQH^L
1RQH^L RI^L WKH^L)LONUDWH^L ZDV^L UHDWHG^L LQWR^L \$VSHQ^L &UHNR^L DOGL WKHUH^L ZHHL QR^L QHJDALYH^L L
ZDWHU^L \$WODQNLFL 5LFKI LHOG^L QRALI LG^L 86^L (3\$^L RI^L WKLV^L FRQGLWRQ^L E\ L HDPL^L RQ^L -XQH^L ± ←

x^L 2Q^L -XQH^L ± ☯ L ± !! ¶ → L WKUHH^L SURSDQH^L WDQNV^L SUHMXUH^L UHOLHI^L YDOHV^L ♂ 359V^L L ZHHL UH^L

x^L 3URSDQH^L ZDV^L GHOLYUHG^L RQ^L -XQH^L T !! ☯ L ± !! ¶ → L

&8' L DOGL '6^L

x^L &RPSOLDQFH^L VDPSOLQJ^L ZDV^L FRPSCHWGL^L RQ^L -XQH^L ¶ L DOGL -XQH^L ± !! ☯ L ± !! ¶ → L IRUL WKH^L
♂ +'6^L 7UHDWPHQW^L 30DQW^L LQIOXHQW^L DQG^L HIIIXHQW^L &8' ☯ L DOGL '6⁴ L L)ORZ^L UDWAH^L UHFRUGH^L
DQG^L WUHDWHG^L ZDWHU^L GLVFKDWH^L IURPL WKH^L +'6^L 7UHDWPHQW^L 30DQW^L DUH^L LQFOXHG^L LQ^L 7DEOH^L T
WKH^L +'6^L 7UHDWPHQW^L 30DQW^L RSHUDWLQDO^L GDWL^L IRUL -XQH^L ± !! ¶ → L LV^L SUHMHQWGL^L LQ^L 7DE^L
DQDOOWLFDO^L UHIXQW^L IURPL WKH^L OD\ L ¶ → ☯ L ± !! ¶ → ☯ L ± OD\ L ↑ ☯ L ± !! ¶ → ☯ L DOGL -XQH^L
SUHMHQWGL^L LQ^L 7DEOH^L ↑ L 7KH^L UHIXQW^L IURPL WKH^L -XQH^L ± !! ☯ L ± !! ¶ → L VDPSOLQJ^L HY^L
VXEHTXHQW^L PRQWKO\ L UHSRUW^L L L

x^L 6DPSOLQJ^L RI^L +'6^L JHQHUDWGL^L VROLGV^L ZDV^L FRPSCHWGL^L RQ^L OD\ L ↑ ☯ L ± !! ¶ → L IRUL FKDUDFWH^L
SUHMHQWGL^L LQ^L 7DEOH^L ± L

x^L 2Q^L -XQH^L ± ☯ L ± !! ¶ → ☯ L WKH^L +'6^L 7UHDWPHQW^L 30DQW^L VKXWGRZQ^L IRUL CHW^L WKQQL^L T KRXV^L T
IORFFXODQW^L V\WHP^L 7KH^L '6^L DOGL &8' L FROOHFLRQ^L DOGL FRQYH\ DQFH^L V\WHPV^L FRQWLQXHG^L WR^L R^L
LQHUXSALRQ^L GXULQJ^L WKLV^L SHURG^L

x^L 2Q^L -XQH^L ¶ T ☯ L ± !! ¶ → ☯ L WKH^L +'6^L 7UHDWPHQW^L 30DQW^L VKXWGRZQ^L IRUL DSSUR[LPDWHO\ L ← L KRX^L
ZLWKLQ^L WKH^L OLPH^L WRUDJH^L KRSSHU^L L L ODQWHDQFH^L ZDV^L SHIRUPHG^L RQ^L WKH^L OLPH^L GHOLYUH^L V^L
DQG^L &8' L FROOHFLRQ^L DOGL FRQYH\ DQFH^L V\WHPV^L FRQWLQXHG^L WR^L RSHUDWH^L ZLWKRXW^L LQHUXSALRQ^L
SHURG^L

x^L 2Q^L -XQH^L ± ¶ T ☯ L ± !! ¶ → ☯ L \$WODQNLFL 5LFKI LHOG^L VXEPLWVHG^L WR^L 86^L (3\$^L DL :DWH^L ODWHU^L
1RALI LFDWLRQ^L /HWHL RI^L GLVSRVDO^L RI^L WUHDWPHQW^L JHQHUDWGL^L VROLGV^L IURPL WKH^L +'6^L 7UHDWPHQW^L
ZDWHU^L ZDV^L VKLSSHGL^L RI^L V\WHP^L RQ^L -XQH^L ± ¶ T ☯ L ± !! ¶ → L

x^L 2Q^L -XQH^L ± ± ☯ L ± !! ¶ → ☯ L \$WODQNLFL 5LFKI LHOG^L VXEPLWVHG^L WR^L 86^L (3\$^L DL :DWH^L ODWHU^L
1RALI LFDWLRQ^L /HWHL RI^L GLVSRVDO^L RI^L PLVHOOQHXR^L ZDWHU^L JHQHUDWGL^L IURPL WKH^L +'6^L 7
7KH^L ZDWHU^L ZDV^L VKLSSHGL^L RI^L V\WHP^L RQ^L -XQH^L ± → ☯ L ± !! ¶ → L

/ \QGD\ 'HMFKOPEDXOW\ ±\ 8◀ 6◀\ (3\$\\ 5HJLRQ\ L
-XO\ ¶ !! ☀ L ± !! ¶ → L
3DJH\ T\ RI\ L

L

6LWH ZLGH^L

x^L 7KH^L \$AODQNLFL^L 5LFKI LHOGL^L :RUN^L 6HDRVQ^L ♂ DV^L GHILQHG^L LQLWKH^L \$2&□^L FRPPHQFHG^L RQL^L -XQH^L ¶
x^L :RUN^L FROWLQXHG^L RQL^L XSGDWLQJ^L WKH^L /HYLDWKDQL^L OLQH^L 3URMHFW^L 'DADEDVH^L ZLWK^L GDWD^L TURPL^L \$AODQ
DQG^L YDULRXV^L DJHQFLHV^L
x^L &RPSOHWHG^L URGGL^L PDLQWHDQFH^L DFALYLWLHV^L RQL^L WKH^L 1HYDGD^L DQG^L &DOLIRUQLD^L \$FFHM^L 5RDGV^L LQFC
JUDGLQJ^L DQG^L DSSOLQJ^L GAW^L VXSUHWDQW^L LQL^L TURQW^L RI^L UHVLGHQFH^L RQL^L WKH^L 1HYDGD^L \$FFHM^L
x^L 2Q^L -XQH^L ± !! ¶ L ± !! ¶ → ¶ L DL FRQIHUHQFH^L FDOD^L ZDV^L FRQGXFWHG^L ZLWK^L WKH^L 8◀ 6◀ L (3\$^L WR^L
XSGDWLQJ^L
x^L \$AODQNLFL^L 5LFKI LHOGL^L SHURQQHOL^L FROWLQXHG^L WR^L LPSOHPHQW^L WKH^L +DJDUGRXV^L &RQGLWLQV^L 5HMSRQWHL^L
&UXVKHUL^L 5RDG^L ,QWDELOLW^L ♂ FRS\^L SURYLGHG^L WR^L 8◀ 6◀ L (3\$^L RQL^L OD\^L ¶ T^L ¶ L ± !! ¶ → □^L
,QWDELOLW^L ORQIWRULQJ^L 3ODQ^L ♂ FRS\^L SURYLGHG^L WR^L 8◀ 6◀ L (3\$^L RQL^L OD\^L ¶ T^L ¶ L ± !! ¶ → □^L

\$&7,9,7,(6^L)25^L 83&20,1*^L 0217+^L

\$VSQ^L GHS^L

x^L &RQWLQXH^L RSHUDWLRQ^L RI^L WKH^L \$6%^L 7UHDAPHQW^L 6\WHP^L LQ^L UHFLUFODWLRQ^L PRGH^L DQG^L FRQWLQXH^L P
PDLQWHQDQFH^L LWHPV^L RXWOLQHG^L LQ^L WKH^L DPHQGHG^L 5\$:3^L

X^L &RQWLOQXH^L VROLGV^L PDQDJHPHQW^L L L

L

&8' L DQG L '6

X^L %HJLQ^L T^{!!} L^{GD}\L^{QWHLPL} &RPELQHG^L 7UHDWPHQW^L ,&7\ L^{GHPHQWUDWLROQ}^L E\ L^{ECHQGLQJ}^L ZDWHUV^L
3RQG\ L^{ZLWK} &8' L^{DQG}^L '6^L ZDWHUL^L VWRUHG^L LQ^L 3RQG^L + ▲ L

x^L &RQWLOQH^L +'6^L 7UHDAPHQW^L 6\WHP^L URXWLCH^L 2 0^L RI^L WKH^L +'6^L 7UHDAPHQW^L 6\WHP^L DV^L RXWOLC^L
5\$:34^L

x^L 'LVS RVMH L RI L GHZDWHUHG L VOXGJH L LQL GHZDWHUHQJ L ELOV L SHAGLQJ L FKUDUFRWHL 1DWLRQ L UHMXQW L

x^L 5 E H Y L Q P H L G O Y M L L

1

6LWH ZLGH

x^L &RQWLOXH^L WR^L SURYLGH^L SURMHFW^L SURUHWL^L XSGDWH^L WR^L WKH^L 8◀ 6◀ L (3\$^L YLD^L FRQIHUHQFH^L
FRQIHUHQFH^L FDQOL^L LV^L FQWHQW^L VPKHGQHG^L IRU^L -XO\^L ¶ ↗ ☀ L ± !! ¶ → ▲ L

x^L &ROWQXH^L UFDGL ZRNL^L DVL ZHDL^L DVL PDLQWHDCH^L RI^L %03V^L IRUL VARPL ZDWHUL PROD JPHOW L

L

4XQWHD\ \downarrow 5.↑)6\ \downarrow 3URUHW\ \downarrow 5HSRW\ \downarrow

\$V^L UHTXLHGL E\^L 3DUDJUDSK^L \+T^L RI^L WKH^L 8\$2^o₂ L WKH^L IROORZLQJ^L 4XDUWHUO^L 3URJUHWL^L 5HSR^L, QYHVWLDALRQ^L DQGL^L) DVLELOLW^L 6\XG^L \+ 5, \+ 6^L DFALYLVH^L GHMULEHV^L \+ D^L WKH^L DFLRQV^L V^L 8\$2^L GXULQJ^L WKH^L SULRU^L TXDUWHU^o₂ L E^L WKH^L ZRUN^L SODQQHG^L IRU^L WKH^L QH\W^L TXDUWHU^o₂ L H^L HQRXOWUHG^L RU^L DQWLFLSDW\G^L LQFOXGLQJ^L DQ\^L DPWKDO^L RU^L DQWLFLSDW\G^L GHOD^L V^L LQ^L VPKHGCHV^L

/VQGD^L 'HMPKOPEDXOW^L ±^L 8⁴ 6⁴^L (3\$^L 5HJLRQL^L ±^L
-XO\^L ¶ !! ☺ ±^L !! ¶ →^L
3DJH^L +^L RI^L ±^L

L

\$FWLRQVL 7DNHQ^L WR^L &RPSO\^L ZLWK^L WKH^L 8\$2^L

x^L 6XEPLWHGL WKH^L 4XDUWHU\^L 3URJUHW^L 5HSRUW^L IRU^L WKH^L 1LUWW^L TXDUWHU^L RI^L ±^L !! ¶ →^L ±^L \$SULO^L
x^L &RQGXFWHG^L PRQWKO\^L SURJUHW^L FRQIHUHQFH^L FDOOV^L ZLWK^L 8⁴ 6⁴^L (3\$^L ±^L \$SULO^L 0D\> L -XQH^L ±^L
x^L 5HFHLYHG^L CHWWHUL^L TURPL^L 8⁴ 6⁴^L (3\$^L UHJDUGLQJ^L WKH^L VFKHGXCH^L IRU^L WKH^L FRPSCHWRQ^L RI^L WKH^L 5
x^L 5HFHLYHG^L H^L PDLO^L TURPL^L 8⁴ 6⁴^L (3\$^L UHTXHWWLQJ^L FRQNDFW^L LQIRUPDWLRQ^L IRU^L 3HUIRUPDQFH^L (YDOX^L
±^L \$SULO^L T^L ☺ ±^L !! ¶ →^L
x^L 6XEPLWHGL H^L PDLO^L UHMSRQM^L WR^L 8⁴ 6⁴^L (3\$^L 0DUFK^L ±^L H^L PDLO^L UHJDUGLQJ^L DFWLRQ^L ,WHP^L
ORQWKO\^L 6WDWKL^L 8SGDWHL^L &D00^L ±^L \$SULO^L T^L ☺ ±^L !! ¶ →^L
x^L 6XEPLWHGL H^L PDLO^L UHMSRQM^L WR^L 8⁴ 6⁴^L (3\$^L 0DUFK^L ±^L H^L PDLO^L UHJDUGLQJ^L \$WODQWLFL 5LFK^L
SUHMQDWLRQ^L PDWULDO^L IRU^L \$SULO^L →^L FD00^L WR^L GLVFXW^L ±^L !! ¶ →^L 1LHOG^L DFWLYLWHL^L ±^L \$S
x^L 6XEPLWHGL H^L PDLO^L UHTXHWW^L IRU^L VHGLPHQW^L GDWD^L FROOHWHG^L E\^L 1HG^L %ODPN^L TURPL^L ±^L ¶ +^L WR^L
±^L !! ¶ →^L
x^L 5HFHLYHG^L H^L PDLO^L WUDQPLWDO^L RI^L ±^L !! ¶ ↑^L %LRPRQWULQJ^L 5HSRUW^L TURPL^L 'DYLG^L +HUEWA^L 8&
x^L 5HFHLYHG^L H^L PDLO^L TURPL^L 8⁴ 6⁴^L (3\$^L UHJDUGLQJ^L UHFHSW^L RI^L VHGLPHQW^L GDWD^L FROOHWHG^L E\^L 1H^L
WR^L ±^L !! ¶ ↑^L ±^L \$SULO^L T^L ☺ ±^L !! ¶ →^L
x^L 6XEPLWHGL CHWWHUL^L GHMFULELQJ^L SURSRVHGL^L ±^L !! ¶ →^L VQRZPHQW^L PRQWULQJ^L DQG^L PRGLILFDWLRQ^L RI^L
PRQWULQJ^L ±^L \$SULO^L T^L ☺ ±^L !! ¶ →^L
x^L 5HFHLYHG^L H^L PDLO^L UHTXHWW^L IRU^L 1LJXH^L DQG^L WDEODU^L VAPPDU\^L RI^L DYDLODECH^L ZDWHUL^L OHMO^L DQ^L
TURPL^L \$PHQGPHQW^L 1R^L ¶ ¶ ¶ LQHWWLJDWLRQ^L ±^L \$SULO^L →^L ☺ ±^L !! ¶ →^L
x^L 6XEPLWHGL CHWWHUL^L GHMFULELQJ^L LPSCHPHQDWLRQ^L RI^L ±^L !! ¶ →^L 6XUIDPH^L :DWHUL^L ORQWULQJ^L
\$SULO^L →^L ☺ ±^L !! ¶ →^L
x^L (+ PDLO^L WUDQPLWDO^L RI^L FXOWAUDO^L UHMRXUHV^L PRQWULQJ^L VFKHGXCH^L IRU^L ±^L !! ¶ →^L L ±^L \$SULO^L
x^L 5HFHLYHG^L H^L PDLO^L TURPL^L 8⁴ 6⁴^L (3\$^L WUDQPLWLU^L SURSRVHGL DJHQGD^L IRU^L 0D\> L ±^L T^L ☺ ±^L
0HWWLQJ^L ±^L \$SULO^L ¶ ±^L !! ¶ →^L
x^L 5HFHLYHG^L H^L PDLO^L XSGDWHL^L TURPL^L 8⁴ 6⁴^L (3\$^L UHJDUGLQJ^L /5:48%^L ±^L \$WODQWLFL 5LFK1LHOG^L VSULQ^L
HI^L IRUWW^L ±^L \$SULO^L ¶ ±^L !! ¶ →^L
x^L 6XEPLWHGL 2Q^L 3URSHUW^L)5, L :RUN^L 30DQL^L \$PHQGPHQW^L 1R^L ¶ ¶ ¶ L 6XSSCHPHQW^L 1R^L C^L
LQHWWLJDWLRQ^L RI^L JURXQGZDWHU^L VAXIDPH^L ZDWHUL^L LQWUDFWRQ^L LQL XSSHUL /HYLDWKDQ^L &UHN^L L ±^L
x^L 5HFHLYHG^L CHWWHUL^L TURPL^L 8⁴ 6⁴^L (3\$^L DSSURYLQJ^L ±^L !! ¶ →^L VQRZPHQW^L PRQWULQJ^L DQG^L GL^L
HYDSRUDWLRQ^L SDQ^L PRQWULQJ^L ±^L \$SULO^L ¶ ←^L ☺ ±^L !! ¶ →^L
x^L 6XEPLWHGL H^L PDLO^L UHMSRQM^L UHJDUGLQJ^L FRRUGLQDWLRQ^L RI^L 3HUIRUPDQFH^L (YDOXDWLRQ^L VDPSCHV^L
±^L !! ¶ →^L
x^L 6XEPLWHGL H^L PDLO^L UH^L FODUL\ LQJ^L SODQV^L IRU^L ±^L !! ¶ →^L PRQWULQJ^L RI^L LQWUDFWRQ^L QHDUL^L
/HYLDWKDQ^L &UHN^L ±^L \$SULO^L ¶ ←^L ☺ ±^L !! ¶ →^L
x^L 6XEPLWHGL H^L PDLO^L WUDQPLWLU^L XSGDWHL^L 5, I)6^L GRFXPHQW^L WUDFNLU^L VSUHDMKHHW^L ±^L \$SULO^L
x^L 6XEPLWHGL 5, I)6^L 7KUH^L :UHN^L)LHOG^L 6FKHGCH^L 3URMHWLRQ^L IRU^L +^L ±^L I^L ¶ →^L WR^L +^L ¶ ±^L

/VQGD^L 'HMFKDPEDXOW^L ±^L 8[◀] 6[◀] L (3\$^L 5HJLRQL^L L
-XO\ L ¶ !! ☺ L ± !! ¶ → L
3DJH^L ↑ L RI^L L

x^L 5HFHLYHG^L H+ PDLO^L IURPL 8[◀] 6[◀] L (3\$^L UHJDUGLQJ^L FRRUGLQDWLRQ^L RI^L 3HUIRUPDQFH^L (YDOXDWLRQ^L VDP^L
¶ ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L XSGDWHL^L IURPL 8[◀] 6[◀] L (3\$^L UHJDUGLQJ^L /5:48%^L L \$WODQWLFL^L 5LFKILHOG^L VSULQ^L
HIIIRUAW^L ±^L \$SULO^L ± !! ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURPL 8[◀] 6[◀] L (3\$^L WUDQMLWLQJ^L SURSRMHGL^L DJHQGD^L IRU^L OD\ L ± T ☺ L ±
OHWLQJ^L ±^L \$SULO^L ± !! ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L 5HMSRQMH^L WR^L &RPPHQW^L DQG^L)LQDOL 5HIIHUHQFH^L \$UHD^L)5, L :RUN^L 3DQ^L L 5HYLVLRQ^L 1R^L
± !! ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L 7DN^L 6DPSOLQJ^L DQG^L \$ODO\VLV^L 3DQ^L σ 76\$3□ L IRU^L %LRDFHWDDELQW^L 7HWLQJ^L ±^L \$
x^L 5HFHLYHG^L CHWWHL^L IURPL 8[◀] 6[◀] L (3\$^L FRQGLWRQDOL^L DSSURYLQJ^L ± !! ¶ → L VAXIDFH^L ZDWHU^L PRQ^L
\$SULO^L ± + ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURPL 8[◀] 6[◀] L (3\$^L ZLWK^L IROORZ+ XSL DRWLQJ^L LWHPV^L IURPL ZHELODU^L UHJD^L
VDPSONQJ^L SURJUDPL ±^L \$SULO^L ± + ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L CHWWHL^L IURPL 8[◀] 6[◀] L (3\$^L ZLWK^L FRQGLWRQDOL^L DSSURYDOL^L DQG^L GLUHPWLQ^L WR^L FRPPHQFH^L
ZDWHU^L VDPSONQJ^L ±^L \$SULO^L ± + ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURPL 8[◀] 6[◀] L (3\$^L ZLWK^L FRQFXUHQFH^L RQ^L SODQHGL^L 1LHOG^L ZRUN^L IRU^L,
7UHDWPHQW^L 'HPRQWUDALRQ^L ±^L \$SULO^L ± + ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L H+ PDLO^L LQIRUPLQJ^L 8[◀] 6[◀] L (3\$^L RI^L VORSH^L PRYHPHQW^L DERYH^L HDW^L RI^L 3RQG^L + L ±
x^L 5HFHLYHG^L H+ PDLO^L IURPL 8[◀] 6[◀] L (3\$^L ZLWK^L SURSRMHGL^L DJHQGD^L IRU^L DMWLRQRL^L PHWLQJ^L F^L
OD\ L ¶ ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L 5,↑)6^L 7KUHH^L :HN^L)LHOG^L 6FKHGCH^L 3URMHWLRQ^L IRU^L ↑ ± ¶ ↑ L WR^L ↑ ± ¶ ↑ L
x^L 6XEPLWHLG^L (YDOXDWLRQ^L RI^L 7HFQLFDOL^L 5HIXOWL^L DW^L 3HULPHWHL^L 'ULOOLQJ^L /RFDWLRQV^L /2&+ T L D^L
OD\ L ¶ ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L 2Q+ 3URSHUW^L)RFXMHG^L 5HFGDOL^L, QHWHWJDALRQ^L :RUN^L 3DQ^L \$PHQGPHQW^L 1R^L ¶ ± L 6^L
1R^L ¶ ± L 7DN^L 6DPSOLQJ^L DQG^L \$ODO\VLV^L 3DQ^L IRU^L &DPS^L, VEHOO^L +\GURFDUERQ^L, QHWHWJDALRQ^L
x^L 5HFHLYHG^L H+ PDLO^L IURPL 8[◀] 6[◀] L (3\$^L UHTXHWAQJ^L VWDWV^L XSGDWHL^L IRU^L ¶ □ L TLVK^L LQHWHWJDALRQ^L
± □ L SODQW^L VDPSONQJ^L GDWL^L VXPPDU^L ±^L OD\ L ± ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L +DJDUGRXV^L &RQGLWRQV^L 5HMSRQMH^L 3DQ^L UHOMHG^L WR^L &UVMKHUL^L 5RDGL 60RSH^L, Q^L
OD\ L ± ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L 8[◀] 6[◀] L (3\$^L DSSURYDOL^L RI^L \$PHQGPHQW^L ¶ ¶ L 6XSSCPHQW^L 1R^L L ¶ L σ 8SSHUL^L /H^L
LQHWHWJDALRQ^L L 6XSSCPHQW^L 1R^L L ± L σ /RZHU^L /HYLDWKQ^L &UHN^L PRQWULQJ^L L ± L OD\ L ±
x^L 6XEPLWHLG^L H+ PDLO^L UHMSRQMH^L WR^L 8[◀] 6[◀] L (3\$V^L + ↑ ± + ↑ ¶ → L UHTXHWAQJ^L RQ^L XSGDWHL^L RQ^L DFW^L
UHJDUGLQJ^L ± !! ¶ → L 1LHOG^L VDPSONQJ^L SURJUDPL ±^L OD\ L + ☺ L ± !! ¶ → L
x^L 6XEPLWHLG^L DRNQRZCHGJPHQW^L RI^L UHFHSW^L RI^L 8[◀] 6[◀] L (3\$V^L \$SULO^L + ☺ L ± !! ¶ → L CHWWHL^L UHJDUG^L
OD\ L + ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L 8[◀] 6[◀] L (3\$^L DSSURYDOL^L RI^L)LQDOL 5HYLVHG^L 5,↑)6^L 4\$33^L L 5HYLVLRQ^L 1R^L L ± L ±
x^L 6XEPLWHLG^L 5,↑)6^L 7KUHH^L :HN^L)LHOG^L 6FKHGCH^L 3URMHWLRQ^L IRU^L ↑ ± ← ± ¶ → L WR^L ↑ ± L ± ↑ ¶ → L

/VQGD^L 'HMPKOPEDXOW^L ±^L 8[◀] 6[◀] L (3\$^L 5HJLRQL^L L
-XO\ L ¶ !! ☺ L ± !! ¶ → L
3DJH^L F L RI^L L

x^L 5HFHLYHG^L H[†] PDLO^L IURPL^L 8[◀] 6[◀] L (3\$^L DFNQRZOHGJLQJ^L UHFHLSW^L RI^L \$SULO^L + ☺ L ± !! ¶ → L
VFHKHGCH^L DQG^L UHTXHWW^L IRU^L :DMKRHL^L 6LVW^L 7RXUL^L DQG^L ± !! ¶ + L)LVK^L DQGL^L 3DQW^L 'DAD^L ±^L OD\^L
x^L 6XEPLWAG^L H[†] PDLO^L ZIWK^L 3URYLVLRQDO^L)ORZ^L 'DAD^L IRU^L \$VSHQL^L 6HHS^L DQG^L &8'^L IRU^L ¶ ↑
T ↓ T ¶ ↑ ± !! ¶ → L ±^L OD\^L ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L FRUHFHWAG^L 3URYLVLRQDO^L)ORZ^L 'DAD^L IRU^L \$VSHQL^L 6HHS^L DQG^L &8'^L IRU^L ¶ ↑
±^L OD\^L ¶ ¶ ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L H[†] PDLO^L UHSRQM^HL WRL^L 8[◀] 6[◀] L (3\$^L 2V^L SURSRM^HG^L DJHQGD^L IRU^L DMHUGRRQ^L PHW^L
OD\^L ¶ ± ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L PHPRUDQGXPL^L ZIWK^L XSGDWAG^L REVHUYDALRQV^L UHODWLQJ^L WRL^L WKH^L LQWDELOM^L RI^L WKH^L
6ORSH^L, QWDELOM^L ±^L OD\^L ¶ ± ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L 5,↑)6^L 7KUHH^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHFLRQ^L IRU^L ↑ ± ¶ ↑ ± ¶ → L WRL^L F ↑ ± ± ¶
x^L 5HFHLYHG^L H[†] PDLO^L IURPL^L 8[◀] 6[◀] L (3\$^L WUDQVPLWALQJ^L 8[◀] 6[◀] L)RUHWW^L 6HUYLFH^L SURSRM^HG^L DJHQGD^L
PHW^L QWDELOM^L ±^L OD\^L ¶ ← ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L 8[◀] 6[◀] L (3\$^L H[†] PDLO^L UHTXHWW^L IRU^L LQIRUPDWLRQ^L UHJDUGLQJ^L WKH^L FDSSLQJ^L RI^L ICRLQJ^L
&UXVKHU^L 5RDG^L 6ORSH^L, QWDELOM^L ±^L OD\^L ± ± ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L ORQWRULQJ^L 3DQ^L IRU^L &UXVKHU^L 5RDG^L 6ORSH^L, QWDELOM^L ±^L OD\^L ± ± ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L 5,↑)6^L 7KUHH^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHFLRQ^L IRU^L ↑ ± ± ± ¶ → L WRL^L F ↑ ± ± ¶
x^L 3DUWFLSDWAG^L LQ^L 7HFKQLFDOL^L OHWALQJ^L ZIWK^L 8[◀] 6[◀] L (3\$^L /5:4&%^L DQG^L 8[◀] 6[◀] L)RUHWW^L 6HUYLFH^L
WRL^L GLVFXW^L)HDVLELOM^L 6W^L SODAQ^L QWDELOM^L DQG^L RWKHU^L 5PHGLDOL^L, QWDELOM^L LWXHV^L ±^L OD\^L
x^L 5HFHLYHG^L 8[◀] 6[◀] L (3\$^L FRPPHQW^L RQL^L \$PHQGPHQW^L ¶ ± L 76\$3^L IRU^L &DPSL^L, VEHOO^L +\GURFQDUEQ^L, QW
±^L OD\^L ± ± ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L H[†] PDLO^L ZIWK^L FRQIHUHQFH^L FDQOL^L LQWDELOM^L DQG^L JXLGDQFH^L SDFNDJH^L IRU^L 8[◀] 6[◀] L (3\$^L
IRU^L DRWLYLWLHV^L LQYROYLQJ^L IOXLG^L KDJDUGL^L VIWWDALRQ^L ±^L OD\^L ± ± ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H[†] PDLO^L WUDQVPLWALQJ^L 8[◀] 6[◀] L (3\$^L PHPR^L UHJDUGLQJ^L)< L !! ¶ → L +4^L FRQXQWDELOM^L
LQYROYLQJ^L IOXLG^L KDJDUGL^L VIWWDALRQ^L ±^L OD\^L ± ± ¶ → L
x^L 5HFHLYHG^L H[†] PDLO^L IURPL^L /5:4&%^L UHTXHWWALQJ^L ZHOO^L FRQWUXFLRQ^L DQG^L ZDWHU^L CHMHOL^L LQIRUPDWLRQ^L
LQWDELOM^L QHDL^L &UXVKHU^L 5RDG^L ±^L OD\^L ± ± ¶ → L
x^L 6XEPLWAG^L UHSRQM^HL WRL^L 8[◀] 6[◀] L (3\$^L FRPPHQW^L DERXW^L WKH^L QHGL^L IRU^L LQHVALJDALRQ^L RI^L WKH^L
UHODW^L WRL^L URDG^L JUDGLQJ^L DQG^L VQRZ^L UHPRYDOL^L DRWLYLWLHV^L ±^L OD\^L ± ± ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H[†] PDLO^L IURPL^L 8[◀] 6[◀] L (3\$^L DFNQRZOHGJLQJ^L DWHMWPHQW^L RI^L WKH^L VKDOORZ^L H[FDYDWLRQ^L
JUDGLQJ^L DQG^L VQRZ^L UHPRYDOL^L DRWLYLWLHV^L ±^L OD\^L ± ± ☺ L ± !! ¶ → L
x^L 6XEPLWAG^L H[†] PDLO^L UHSRQM^HL WRL^L 8[◀] 6[◀] L (3\$^L OD\^L ± ± L LQTXLU^L DERXW^L WKH^L FDSSLQJ^L RI^L
OD\^L ± ± ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H[†] PDLO^L IURPL^L 8[◀] 6[◀] L (3\$^L UHTXHWWALQJ^L DMLWDQFH^L ZIWK^L SUHSDDUDALRQ^L RI^L +4^L FRQXQW
IRU^L %'↑ 3&^L SODOQHGL^L ZRUN^L DRWLYLWLHV^L ±^L OD\^L T !! ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H[†] PDLO^L IURPL^L 8[◀] 6[◀] L (3\$^L LQTXLULQJ^L DERXW^L GDWD^L YDOLGDWLRQ^L SURFH^L DQG^L UHTXHWW^L
, , L GDWD^L UHTXHWW^L SDRNHWW^L ±^L OD\^L T !! ☺ L ± !! ¶ → L

/VQGD^L 'HMPKOPEDXOW^L ± L 8[◀] 6[◀] L (3\$^L 5HJLRQL L
-XO\ L ¶ !! ☺ L ± !! ¶ → L
3DJH L → L RI L L

x^L 6XEPLW^{HG}L H+ PDLO^L WUDQMLWLQJ^L GUDIW^L VOLGHV^L IRU^L FRQIHUHQFH^L FDOD^L WR^L GLVFXW^L 8[◀] 6[◀] L (3\$^L IRU^L DFLYLYLHV^L LQYROYLQJ^L IOXGL^L KDJDUG^L VVWWDALRQV^L ± L OD\ L T !! ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L 8[◀] 6[◀] L (3\$^L UHTXHVLQJ^L DGGLWLRQD^L FODULI LFDALRQ^L RI L SUHM-QWDALRQ^L
FRQXQWDALRQ^L IRU^L DFLYLYLHV^L DW^L WKH^L %'↑ 3&L ± L OD\ L T ¶ ☺ L ± !! ¶ → L
x^L 6XEPLW^{HG}L H+ PDLO^L ZLWK^L SURYLVLRQD^L)ORZ^L 'DWD^L IRU^L \$VSHQ^L 6HHS^L DQG^L &8' L IRU^L \$
OD\ L T ¶ ☺ L ± !! ¶ → L
x^L 6XEPLW^{HG}L 5,↑)6^L 7KUH^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHWLRQ^L IRU^L ↑ ± L ↑ ¶ → L WR^L ↑ ± ¶ ↑ L
x^L 6XEPLW^{HG}L UHSRQM^HL WR^L (3\$V^L OD\ L ± L ☺ L ± !! ¶ → L CHMHUL^L FRQFHQLQJ^L WKH^L &UXVKHUL^L
ORQIWRULQJ^L 3DQ^L ± L OD\ L T ¶ ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L PXQWSCH^L H+ PDLOV^L IURP^L 8[◀] 6[◀] L (3\$^L UHTXHVLQJ^L FODULI LFDALRQ^L RI L SUHM-QWDALRQ^L P
(3\$^L +4^L FRQXQWDALRQ^L IRU^L DFLYLYLHV^L LQYROYLQJ^L IOXGL^L KDJDUG^L VVWWDALRQV^L ± L -XQH^L ¶ ☺ L ± L
x^L 6XEPLW^{HG}L PXQWSCH^L H+ PDLOV^L IURP^L 8[◀] 6[◀] L (3\$^L SURYLGQJ^L FODULI LFDALRQ^L RI L SUHM-QWDALRQ^L P
(3\$^L +4^L FRQXQWDALRQ^L IRU^L DFLYLYLHV^L LQYROYLQJ^L IOXGL^L KDJDUG^L VVWWDALRQV^L ± L -XQH^L ¶ ☺ L ± L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L /5:4&%L WUDQMLWLQJ^L FRQHSWAD^L SODQ^L DQG^L GUDZLQJV^L IRU^L VORSH^L W
QHDUL^L 3DQ^L + L ± L -XQH^L ↑ ☺ L ± !! ¶ → L
x^L 6XEPLW^{HG}L 5,↑)6^L 7KUH^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHWLRQ^L IRU^L ↑ ± L ↑ ¶ → L WR^L ↑ ± T ↑ ¶
x^L &RQGXFW^{HG}L FRQIHUHQFH^L FDOD^L ZLWK^L 8[◀] 6[◀] L (3\$^L UHSUHM-QWDALYHV^L WR^L GLVFXW^L VHHS^L PRQIWRULQJ^L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L 8[◀] 6[◀] L (3\$^L UHTXHVLQJ^L XSGDWHL RQ^L WDWAV^L RI L VRKGCHV^L ↑ GHOLYHUL^L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L /5:4&%L SURYLGQJ^L QWALI LFDALRQ^L RI L /5:4&%L FRPPHQPHQW^L RI L SRQG^L Z
WUDWPHQW^L ± L -XQH^L → ☺ L ± !! ¶ → L
x^L 6XEPLW^{HG}L H+ PDLO^L WUDQMLWLQJ^L WKH^L WDWAV^L RI L DQG^L VRKGCH^L RI L LHOG^L DFLYLYLHV^L UHTXLU^L
-XQH^L ☺ L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L 8[◀] 6[◀] L (3\$^L UHTXHVLQJ^L PRQIWRULQJ^L RI L VHHSV^L RQ^L /HYLDWKDQ^L &U
-XQH^L ¶ ± L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L /5:4&%L SURYLGQJ^L GUDIW^L SURMHW^L SODQ^L DQG^L GUDZLQJV^L IRU^L VORSH^L W
QHDUL^L 3DQ^L + L ± L -XQH^L ¶ ± L ± !! ¶ → L
x^L 6XEPLW^{HG}L H+ PDLO^L WUDQMLWLQJ^L WKH^L UHGXOW^L RI L VARUP^L ZDWHU^L VQRZ^L PHQW^L 3HUIRUPDQFH^L (YDC
UHFHLYHG^L RQ^L \$SULO^L → ☺ L ± !! ¶ → L ± L -XQH^L ¶ ± L ± !! ¶ → L
x^L 6XEPLW^{HG}L 5,↑)6^L 7KUH^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHWLRQ^L IRU^L ↑ ¶ ± L ↑ ¶ → L WR^L ↑ ± T !! ↑
x^L 5HFHLYHG^L 8[◀] 6[◀] L (3\$^L FRPPHQW^L RQ^L \$WODQWLFL 5LFKILHOG^L UHSRQM^HL WR^L 8[◀] 6[◀] L (3\$^L
*HRWHRKQLFDOL 76\$3^L ± L -XQH^L ¶ ± L ± !! ¶ → L
x^L 5HFHLYHG^L 8[◀] 6[◀] L (3\$^L FRPPHQW^L RQ^L ,QWHLPL ± !! ¶ ↑ + ± !! ¶ ↑ L 8SSHUL^L 7ULEXWDU^L 5HSRUW^L ± L
x^L 6XEPLW^{HG}L H+ PDLO^L WUDQMLWLQJ^L WKH^L UHGXOW^L RI L VXUIDFH^L ZDWHU^L 3HUIRUPDQFH^L (YDOXDALRQ^L VD
RQ^L OD\ L ☺ L ± !! ¶ → L ± L -XQH^L ¶ ± L ± !! ¶ → L
x^L 5HFHLYHG^L H+ PDLO^L IURP^L 8[◀] 6[◀] L (3\$^L UHTXHVLQJ^L GDWD^L UHODWGL WR^L JURXQGZDWHUL CHMOC
PKHPLW^L DQG^L PRQIWRULQJ^L SRQW^L VXUYH^L LQ^L WKH^L YLFLQW^L RI L &UXVKHUL^L 5RDGL 60RSH^L,QW
± L ± !! ¶ → L
x^L 6XEPLW^{HG}L ± !! ¶ ± L &XOMKUDO^L 5HVRXUFHV^L ORQIWRULQJ^L 5HSRUW^L ± L -XQH^L ¶ ± L ± !! ¶ → L

/VQGD^L 'HMPKOPEDXOW^L ±^L 8[◀] 6[◀] L (3\$^L 5HJLRQL^L L
-XO\^L ¶ !! ☺ L ± !! ¶ → L
3DJH^L ← L RI^L L

x^L 6XEPLWNLQJ^L H† PDLO^L WUDQMLWLQJ^L GDWD^L SDFNDJHL^L UHODWHG^L WR^L &UXKHUL^L 5RDGL^L VORSH^L LQWDELOLW^L
8[◀] 6[◀] L (3\$^L UHTXHWL^L RI^L -XQH^L ¶ + ☺ L ± !! ¶ → L ± L -XQH^L ¶ + ☺ L ± !! ¶ → L
x^L 6XEPLWHL^L UHMSRQM^L WR^L 8[◀] 6[◀] L (3\$^L FRPPHQW^L RQL^L *URXQGDWHL^L 7HFQLFDOL^L 'DWD^L 6XPDU^L
5HVLVLRQL^L 1R[◀] L ± L ± L -XQH^L ¶ + ☺ L ± !! ¶ → L
x^L 6XEPLWHL^L 5,↑)6^L 7KUHL^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHWLRQL^L IRUL^L ↑ ¶ ↑ ¶ → L WR^L → ↑ → ↑ ¶
x^L 5HFHLYHGL^L 8[◀] 6[◀] L (3\$^L DSSURYDO^L RI^L)RFXHGL^L)HDMLELOLW^L 6WKG\^L ♂))6[□] L :RUN^L 30DQL^L IRUL^L WKH^L
± L ± ☺ L ± !! ¶ → L
x^L 6XEPLWHL^L 5,↑)6^L 7KUHL^L :H+N^L)LHOG^L 6FKHGCH^L 3URMHWLRQL^L IRUL^L ↑ ± ↑ ¶ → L WR^L → ↑ ¶ + ↑ ¶
x^L 6XEPLWHL^L *HRWFQQLFDOL^L &RPPHQW^L RQL^L /5:48%^L 3URMHWL^L 30DQL^L IRUL^L 7HPSRUDU^L VOLGH^L 5HSIDL^L
3RQL^L T^L 5RDGL^L ± L -XQH^L ± + ☺ L ± !! ¶ → L
x^L 6XEPLWHL^L)RFXHGL^L)HDMLELOLW^L 6WKG\^L \$VSHQL^L 6HHS^L &RQMH\DOFH^L 7UHDWDELOLW^L, QHWWLJDWLRLQ^L :
-XQH^L ± + ☺ L ± !! ¶ → L
x^L 6XEPLWHL^L HPDLO^L WR^L 8[◀] 6[◀] L (3\$^L UHJDUGLQJ^L 3(L 6DPSOH^L &RRUGLQDWLRQL^L ± L -XQH^L ± + ☺ L ± !! ¶
x^L 5HFHLYHGL^L /5:48%^L FRPPHQW^L RQL^L \$PHQGPHQW^L 1R[◀] L ¶ ¶ ☺ L 6XSSOHPHQW^L 1R[◀] L ¶ L + L 76\$3^L
:DWHU^L *URXQGDWHL^L, QHWWLJDWLRLQ^L LQL^L 8SSHUL^L /HYLDWKDQL^L &H+N^L ± L -XQH^L ± ☺ L ± !! ¶ → L
x^L 6XEPLWHL^L H† PDLO^L ZIWKL^L 3URYLVLRQDOL^L)ORZ^L 'DWD^L IRUL^L \$VSHQL^L 6HHS^L DOGL^L &8'^L IRUL^L OD\^L ± !! ¶
± !! ¶ → L

:RUN^L 30DQHGL^L IRUL^L WKH^L 1HWL^L 4XQJWHL^L

x^L &RQGXFW^L ORQWKO\^L 3URJUHW^L &RQIHUHQFH^L &DOOV^L ZIWKL^L 8[◀] 6[◀] L (3\$^L ± L -XO\^L \$XJXWW^L 6HSWHE^L
x^L &RQWQXH^L ± !! ¶ → L PRQWULQJ^L DQGL RAKHUL^L LHOG^L VDPSOLQJ^L DFALYWLHV^L ± L -XO\^L \$XJXWW^L
x^L 6XEPLW^L 7HFQLFDOL^L 'DWD^L 6XPDU^L 5HSRUW^L IRUL^L VVHDP^L VHGLPHQW^L DQGL TORRGSODLQL^L VRLO^L ± L -X^L
x^L 6XEPLW^L 7HFQLFDOL^L OHPRUDQGP^L GHMFULELQJ^L HYDOXDWLRQL^L RI^L SUHOLPLQDU^L UHIIHJUHQFH^L GDWD^L ± L -X^L
x^L &RQWQXH^L DQDOLVVL^L RI^L 5, L VDPSOLQJ^L UHAXOWL^L LQL^L VASSRUW^L RI^L SUHSDUDWLRQL^L RI^L DL FR^L
FRKUDFWHUL]DWLRQL UHSRUW^L LQFOXGLQJ^L PHGLD+ VSHFLILFL^L 7HFQLFDOL^L 'DWD^L 6XPDU^L 5HSRUW^L
FDQHQGDUL^L \HDU^L ± !! ¶ → L

3URECHPV^L (QFRXQWUHGL^L RUL^L \$QNLFLSDWHL^L

x^L 3RWHQWLDO^L VFKHGCH^L LPSDFAW^L PD\^L RFFXUL^L LQL^L UHODWLRQL^L WR^L FKDQJHV^L LQL^L WKH^L VFRSH^L RI^L)5, L
♂ H^L J^L ☺ L ELRDFH\DELOLW^L WHWWLQJ^L SHQGLQJ^L 8[◀] 6[◀] L (3\$^L UHYLHZ^L DQGL DSSURYDO^L RI^L RWWW^L
DQGL \$QDOLVVL^L 30DQ[◀] L

L L L L L L L L L L L L L L L L

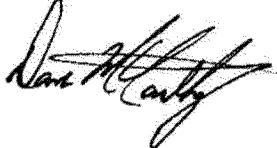
L

L

, L \RXL KDYH^L DQ^L TXHWWLRQV^L RUL^L FRPPHQW^L SODVH^L IHHOL^L TUH^L WR^L FRQWDFW^L PH^L DW^L ♂ ↑ → □
\$QWKRQ\ %URZQHES^L FRP^L

/VQGD^L 'HMFKOPEDXOW^L ±^L 8◀ 6◀ ^L (3\$^L 5HJLRQL^L
-XO\ ^L ¶ !! ☺ ^L ± !! ¶ → ^L
3DJH^L ^L RI^L ^L

^L
6LQFHUHO\ ☺ ^L
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Dan McCarthy
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7RQ\ ^L %URZQ^L
3URMFW^L ODQDJHU^L
^L
\$WDFKPHQW^L
^L

7DEOH^L ¶ ±^L \$VSHQ^L 6HS^L %LRUHDFWRU^L 7UHDWPHQW^L 6\WHP^L ±^L &RPSOLDQFH^L 6DPSCH^L 5H\XOWW^L
7DEOH^L ±^L ±^L \$VSHQ^L 6HS^L %LRUHDFWRU^L 7UHDWPHQW^L 6\WHP^L ±^L 5H\PHQW^L)ORZ^L S+^L DQG^L 253^L)
7DEOH^L ±^L ±^L &KDOQHQ^L 8QCHUGDLQ^L 'HOD^L 6HS^L DQG^L +'6^L 7UHDWPHQW^L 30DQW^L ±^L)ORZ^L 5DWHM^L
7DEOH^L ±^L ±^L +LJK^L 'HQMLW^L 60XGUH^L 7UHDWPHQW^L 30DQW^L ±^L 2SHUDALRQDOL^L 'DAD^L 6XPPDU\ ^L
7DEOH^L ↑^L ±^L +LJK^L 'HQMLW^L 60XGUH^L 7UHDWPHQW^L 30DQW^L ±^L &RPSOLDQFH^L 6DPSCH^L 5H\XOWW^L
7DEOH^L ±^L ±^L +LJK^L 'HQMLW^L 60XGUH^L 7UHDWPHQW^L 30DQW^L ±^L /DERUDWRU\ ^L \$QDOWLFDO^L 5H\XOWW^L RI^L
*HQHUDWHL^L 6ROLGV^L

^L
FF^L L L L 'RXJODVL &DUH\ ☺ ^L /DKRQNDQ^L 5HJLRQDOL :DW\HUL 4XDOLW^L &RQWURO^L %RDUG^L
5RQDOG^L +DOMH\ ☺ ^L \$WODQWLFL 5LFKILHOG^L &RPSDQ\ ^L
1DWDQDQ^L %ORPN^L %3^L
-DRN^L ODLUHULVRQ^L \$WODQWLFL 5LFKILHOG^L &RPSDQ\ ^L
5HJLQDOG^L ,ODR^L \$WODQWLFL 5LFKILHOG^L &RPSDQ\ ^L
\$GDP^L &RKHQ^L (VT◀ ☺ ^L 'DYLV^L *UDKDP^L ±^L 6A\KEEV^L //3^L
'DYH^L OF&DUNK\ ☺ ^L &RSSHUL^L (QYLURQPHQWDO^L &RQ\XOWLQJ^L
ODUF^L /RPEDUGL^L \$PHF^L)RWHUL :KH\OHUL (QYLURQPHQW^L ,QIUDW\UXFWXLUH^L ,QF◀ ^L
6DQG\ ^L 5LHM^L (Q6FL^L ,QF◀ ^L

7\$%/(L ¶

\$63(1^L 6((3^L %,25(\$&725^L 75(\$70(17^L 6<67(0^L + ^L &203/, \$1&(^L 6\$03/(^L 5(68/76
-81(^L ± !! ¶ → ^L 0217+/<^L 6800\$5<
'UDW^L + ^L 3URYLVLRCDO^L 'DWD

3DUDPHWU	%DLV	-XCH ^L ¶ ↑ ☰ ↑ ← \$63, 1)	-XCH ^L ¶ ↑ ☰ ↑ → 0+↑	-XCH ^L ¶ ↑ ☰ ↑ → 0+↑	-XCH ^L ¶ ↑ ☰ ↑ → 0+↑	-XCH ^L ¶ ↑ ☰ ↑ → 0+→	-XCH ^L ¶ ↑ ☰ ↑ → 0+→	ODPPLXP ^L 'LVRKDWJH ^L &UWFLUD ^L ♂ PJ↑ /□	\$YHJDJH ^L 'LVRKDWJH ^L &UWFLUD ^L ♂ PJ↑ /□
S+ ^L ♂ V ^L X ^L □	)LHDG	↑ ◀ ↑	→ ◀ ↑ →	→ ◀ !! +	← ◀ ¶ ←	↑ ◀ ↑	↑ ◀ ↑	→ ◀ ↑	↑ ◀ ↑
\$OXPLOXP	'LWROM-	↑	+	+	+	!! ◀ !!	↑	↑	↑
\$UMHQJ	'LWROM-	!! ◀ !!	+	+	+	!! ◀ !!	!! ◀ !!	!! ◀ !!	!! ◀ !!
&DCPLXP	'LWROM-	!! ◀ !!	+	+	+	↑ !! ◀	↑ !! ◀	!! ◀ !!	!! ◀ !!
&DOFLXF	'LWROM-	↓ !!	+	+	+	T ←	↑	↑	↑
&KORULG	7RNDI	↑ ↖	+	+	+	T ↖	↑	↑	↑
&KURPLXP	'LWROM-	!! ◀ !	+	+	+	↑ !! ◀	!! ◀ !!	!! ◀ !!	!! ◀ !!
&RSSHL	'LWROM-	↑ ↖	+	+	+	↑ !! ◀	!! ◀ !!	!! ◀ !!	!! ◀ !!
(WKDR	7RNDI	↑ !!	↑ ¶	↑	→	↑ ¶	↑	↑	↑
+DUGHM	'LWROM-	¶ ↑	+	+	+	¶ ↑	↑	↑	↑
,UR	'LWROM-	¶ ↑	+	+	+	!! ◀	↑ ↖	¶ ↖	¶ ↖
/HDG	'LWROM-	↑ !! ◀	+	+	+	↑ !! ◀	!! ◀ !!	!! ◀ !!	!! ◀ !!
ODUCHMLXP	'LWROM-	↑	+	+	+	↑ ↖	↑	↑	↑
1LFNH	'LWROM-	!! ◀	+	+	+	!! ◀ !!	!! ◀ !!	!! ◀ !!	!! ◀ !!
6HQHQLXF	7RNDI	!! ◀ !	+	+	+	!! ◀ !! !!	13	!! ◀ !!	!! ◀ !!
6XO1DV	7RNDI	↑ ↖	↑ !! !!	↑ ¶ ← !!	↑ ¶ !!	↑ ¶ ↑ !! !!	↑	↑	↑
6XO1LC	7RNDI	+	↑ !! .	↑ ¶	↑ !! .	↑	↑	↑	↑
=LQF	'LWROM-	!! ◀	+	+	+	!! ◀ !! !!	!! ◀ !!	!! ◀ !!	!! ◀ !!
\$FLGLM	7RNDI	↑ ↖	+	+	+	↑	↑	↑	↑
\$ONDOLQWM ^L ♂ %LPDE	7RNDI	↑ ↖	+	+	+	↑ ↖	↑ ↖	↑ ↖	↑ ↖
\$ONDOLQWM ^L ♂ &DUE	7RNDI	↑ ↖	+	+	+	↑ ↖	↑ ↖	↑ ↖	↑ ↖
\$ONDOLQWM ^L ♂ +IGF	7RNDI	↑ ↖	+	+	+	↑ ↖	↑ ↖	↑ ↖	↑ ↖
\$ONDOLQWM ^L ♂	7RNDI	↑ ↖	+	+	+	↑ ↖	↑ ↖	↑ ↖	↑ ↖
7RNDOL ^L 'LWROM-HG ^L	7RNDI	↑ ↖	+	+	+	↑ ↖	↑ ↖	↑ ↖	↑ ↖
7RNDOL ^L 6XVSHQHG ^L 6RDGLV	7RNDI	↑ ↖	+	+	+	↑ ↖	↑ ↖	↑ ↖	↑ ↖

1RWHV

1 S+L YDDOAHV L DUHL LHOG L PHDXAHLPHQWL DCG L DUHL UHSRUVHG L LQL WADGEGDUG X
2 + LVPKDUJHL FULWHDL DCG L EDVLV L TRU L PD L PXP L DCG L DYHJDJHL YDOXH V L DUHL
3 WKH 5HTXHW L TRU L \$SSURYDOL RI L ORGLI FDALRQ L WR L WKH 5HPRYDOL \$FALQD L DA
4 /HM DWKQOL OICHL QHEP DMQPL & 84 64 L (353 L T L II L II L □

SEE HYDROWAY

L + &RQWLUWHQWL WKOWL ZHHL CRW GWHFHGL DUH L OLWHL DV L | | L DQG L WKH L UHSRUW L QJ L OPLW L
VKRZQK
| + | L + 'LVFKOUJHL FULWHL L CRW HWADEOLVXHG L RUL YDOXHL CRW PHDXUHG
- L + 5HGXWL CRW HGZL ZVAKL | - | L DUH L DO' HWAFLDHWGL YDOXHL RUL ZHHL CHWL WKQ L WKH L UHSRUW L QJ L OPL
EWX JUDWHL WKQ L RUL HTXDO L WR L WKH L PHWKRG L GHWAFLRQL OPLW
AL + ,QWUXPHW L UHDWKG L 4& L LV L RXAWLGH L DFFHSNDQFH L OPLW
)9 L + 06 L DQG L RUL 06' L 5HFRYHU L LV L RXAWLGH L DFFHSADECH L OPLW
%L + &RPSRXQG L ZDVL IRXQG L LQ L WKH L EODQN L DQG VDPSCH
PJ L + PLQJUDPV L SHU L OLWHL

78% (上)

\$63(1^L 6((3^L %25(\$7725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S^L \$1^L 253^L),(/^L 0(\$685(0(176

-81(+/-) → 0217+/- 6800\$5<

$${}^{13}\text{C}\text{-NMR} \quad \text{CDCl}_3 + \text{D}_2\text{O}$$

3DJH ← RI

78% (上)

\$63(1^L 6((3^L%, 25(\$&725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S^L \$1^L 253^L),(/^L 0(\$685(0(176

-81(0217+/
6800\$5<

'UDW^L + L 3URYLVRQDO^L 'DWD

7\$%/(L 上

\$63(1^L 6((3^L.% 25(\$&725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S+^L \$1^L 253^L),(/^L 0(\$685(0(176

-81(L + !! ¶ → L 0217+/

'UDW + 3URYLVRQDO 'DWD

3DJH ← RI ←

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7\$%/(^L_L

\$63(1^L 6((3^L %,25(\$&725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S+^L \$1,^L 253^L),(/^L 0(\$685(0(176

-81(^L_L !! ^L →^L 0217+/^L 6800\$5<

'UDW^L +^L 3URYLVLRQDO^L 'DAD

'DAD	\$VSHQ ^L GHS ^L %LRUHDFARUL ^L ,QIOXHQW ^L			ODQKRCH ^L ♫ ^L RU ^L			ODQKRCH ^L ♫ ^L RU ^L			ODQKRCH ^L → ^L RU ^L			\$VSHQ ^L GHS ^L %LRUHDFARUL ^L		
	)CRZ ^L ♂ JSP	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[
!! ← ↑ ⊥ !! ↓	|| T	↑ ▲ !!	↑ ▲ →	↑ T → ▲ T	↑ T → ▲ T	!!	↑ T → ♪ ▲ T	→ ▲	↑ ←	↑ T ♪ ▲ T	→ ▲	↑ →	↑ T ♪ T ▲ T		
!! ↑ !! ↓ ↓	|| T	T ▲ ↑	↑ ▲ T	↑ T ▲ ↑	↑ T ▲ ↑	→ ▲	↑ ↑ ← ▲ T	→ ▲	↑ ↑	↑ L T ♪ ▲ →	→ ▲	↑	↑ ♪ ♪ !! ▲ →		
!! ↑ ♪ → ↓	|| T	T ▲ ↑	↑ ▲ →	↑ ♪ → ▲ ←	↑ ♪ → ▲ ←	← ▲ ♪	↑ ↑ ↑ ▲ T	→ ▲	↑ ↑	↑ L T ▲ ↑	→ ▲	↑	↑ ⊥ ↑ ▲ ♪		
!! ↑ ⊥ ⊥ ↓	|| T	T ▲ ↑	↑ ▲ ↑	↑ T !! ▲	↑ T !! ▲	← ▲ ♪	↑ T ↑ ▲ T	→ ▲	↑ ↑	↑ T ← T ▲	→ ▲	↑	↑ ⊥ ⊥ ⊥ ▲ ←		
♪ !! ↑ !! ⊥ ↓	|| T	T ▲ ↑	↑ ▲ ♪	↑ !! ▲ ♪	↑ !! ▲ ♪	→ ▲	↑ T T ⊥ ▲ ↑	↑ T T	↑ T T	↑ T → ⊥ ▲	→ ▲	↑	↑ T ♪		
♪ !! ↑ !! → ↓	|| T	T ▲ ↑	↑ ▲ ↑	↑ ← ▲ ↑	↑ ← ▲ ↑	→ ▲	↑ T !! ♪ ▲ +	↑ T	↑ T	↑ T ♪ +	→ ▲	↑	↑ ⊥ → ▲ ↑		
♪ !! ↑ ♪ ↑ ↓	|| T	↑ ▲ ♪	↑ ▲ ↑	↑ T !! ▲ ↑	↑ T !! ▲ ↑	+	+	+	+	↑ T ♪ ▲ ▲	+	+	+		
♪ !! ↑ ⊥ ↑ ↓	|| T	↑ ▲ ↑	↑ ▲ ↑	↑ T ⊥ ▲ ↑	↑ T ⊥ ▲ ↑	+	+	+	+	↑ T ↑ ▲ ↑	+	+	+		
♪ !! ↑ T !! ↓	|| T	T ▲ ↑	↑ ▲ ↑	↑ T → ▲ !!	↑ T → ▲ !!	→ ▲	↑ T ↑ ▲ T	↑ T	↑ T ↑ ▲ T	↑ T ↑ T ▲	→ ▲	↑	↑ T !! ↑		
♪ ♪ !! ↑ !! ↓	|| T	T ▲ ♪	↑ ▲ ♪	↑ T ♪ T	↑ T ♪ T	→ ▲	↑ ↑ ↑ ▲ T	→ ▲	↑ ↑	↑ T ⊥ ⊥ ▲	→ ▲	↑	↑ ⊥ → ▲ ↑		
♪ ⊥ !! ♪ ♪ !! ↓	|| T	T ▲ ↑	↑ ▲ ↑	↑ ♪ ↑ ▲ →	↑ ♪ ↑ ▲ →	+	+	+	+	+	+	+	+		
♪ ⊥ ↑ ♪ ⊥ ↓	|| T	+	+	+	+	+	+	+	+	+	+	+	+		
!! ♪ !! ↑ !! ↓	|| T	T ▲ ⊥	↑ ▲ ♪	↑ T ♪ !!	↑ T ♪ !!	→ ▲	↑ T !! ⊥ ▲ →	↑ T	↑ T	↑ T ♪ +	→ ▲	↑	↑ ⊥ → ▲ ↑		
!! ⊥ ↑ ♪ T ↓	|| T	T ▲ ↑	↑ ▲ ↑	↑ ♪ T ▲ ↑	↑ ♪ T ▲ ↑	← ▲	↑ T ↑ ▲ T	↑ T	↑ T ↑ ▲ T	↑ T ↑ T ▲	→ ▲	↑	↑ ⊥ ⊥ ⊥ ▲ ↑		
!! T ↑ ♪ ⊥ ↓	|| T	T ▲ !!	↑ ▲ ↑	↑ ♪ T ▲ ↑	↑ ♪ T ▲ ↑	← ▲	↑ ♪ T ↑ ▲ ♪	↑ ♪ T	↑ ♪ T ↑ ▲ ♪	↑ ♪ T ▲ ♪	→ ▲	↑	↑ T T T ▲ ↑		
!! ⊥ ↑ ♪	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘	↓ ↘		
!! ↑ !! ↓	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ ♪	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ ⊥	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ !! ↓	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ ♪	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ ⊥	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ !! ↓	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ ♪	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ↑ ⊥	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! → !! ↓	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! → ♪ !! ↓	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! → ♪	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! → ⊥	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		
!! ← !! ↓	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗	↓ ↗		

3DJH^L +^L RI^L ←

7\$% (L 上

\$63(1^L 6((3^L %,25(\$&725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S+^L \$1,^L 253^L),(/'^L 0(\$685(0(176
-81(^L ± !! ¶ →^L 0217+/<^L 6800\$5<
'UDW^L +^L 3URYLVLRCDO^L 'DWD

3DJH L ↑ L RI L ←

7\$%/(L 上

\$63(1^L 6((3^L %25(\$725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S+^L \$1^L 253^L),(/^L 0(\$685(0(176

-81(L ± !! ¶ → L 0217+/ \angle 6800\$5<

'UDW^L + L 3URYLVLRQDO^L 'DWD

3DJH ← RI ←

79% (上)

\$63(1^L 6((3^L %25(\$7725^L 75(\$70(17^L 6<67(0^L +^L 5(&(17^L)/2:^L S+^L \$1^L 253^L),(/^L 0(\$685(0(176

-81(+)!!PI → 0217+/ \angle 6800\$5<

'UDW^L + L 3URYLVLRQDO^L 'DWD

3DJH \leftarrow RI \rightarrow

7\$%/(L⁺
 \$63(1^L 6((3^L %,25(\$&725^L 75(\$70(17^L 6<67(0^L + L<sup>5(&(17^L)/2:^L S+^L \$1^L 253^L),(/^L 0(\$685(0(176
 -81(L⁺ !! ¶ → L<sup>0217+/^L 6800\$5<
 'UDW^L + L^{3URYLVLRQDOL} 'DAD</sup></sup>

'DWH	\$VSHQ ^L GHS ^L %LRUHDFARUL			ODQKRC ^L ¶ L ^{RUL}			ODQKRC ^L ¶ L ^{RUL}			ODQKRC ^L → L ^{RUL}			\$VSHQ ^L GHS ^L %LRUHDFARUL		
	,QIOXHQ ^L %LRFHOO ^L ¶ L ^{QIOXHQ^L %LRFHOO^L,QIOXHQ^L}			,QIOXHQ ^L %LRFHOO ^L ¶ L ^{QIOXHQ^L %LRFHOO^L,QIOXHQ^L}			,QIOXHQ ^L %LRFHOO ^L ¶ L ^{QIOXHQ^L %LRFHOO^L,QIOXHQ^L}			,QIOXHQ ^L %LRFHOO ^L ¶ L ^{QIOXHQ^L %LRFHOO^L,QIOXHQ^L}			,QIOXHQ ^L %LRFHOO ^L ¶ L ^{QIOXHQ^L %LRFHOO^L,QIOXHQ^L}		
	)ORZ ^L ♂ JSP	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[	S+ ^L ♂ V◀	253 ^L ♂ P9[
	!! ↑ ↓ ± ← ↓	|| →	+	± ▲	T ←	↑ ▲ ←	+	+	+	+	←	!! T	+ ± +	! !	
	!! ↑ ↓ ± ↓	→	¶ + ▲ +	+	+	+	+	+	+	+	+	+	+	+	

1RWH/

1 \$VSHQ^L GHS^L %LRUHDFARUL LQIOXHQ^L 1ORZ^L UDWH^L PHDXUHPQW^L DUH^L LHOG^L PHDXUHPQW^L FROCHW^L ZLW^L D^L JUDGQW^L
 + /RZ^L S+^L PHDXUHPQW^L GH^L WR^L SRZH^L RWDJH^L DOG^L DMRFLDWG^L FKPLFD^L SXPS^L GRZQNLPH^L GULQ^L WK^L LQHJW^L IDU^L
 + /RZ^L S+^L PHDXUHPQW^L GH^L WR^L LQFUDM^L LQ^L V\WHP^L 1ORZ^L UDWH^L FKPLFD^L GR/LQ^L UDWH^L CDJHG^L EHKG^L WKMH^L
 XGECH^L WR^L SUHYQW^L CHFLUDM^L LQ^L V\WHP^L S+◀
 +)LHOG^L PHDXUHPQW^L DV^L LQHJWGLD^L ELRUHDFARUL PDQKRC^L ZLH^L QRM^L FROCHW^L ZKH^L UHFLUXQDWLRQ^L RSHLDWLRQ^L ;
 LQHJWLSW^L GH^L WR^L VOXGJH^L GHZWHULQ^L RSHLDWLRQ^L ELRFHOO^L IOXKLQ^L R^L RAKH^L PDQWHDQFH^L DRWLYLV^L V◀
 + 253^L PHDXUHPQW^L PDV^L BH^L LQFFXUDW^L GH^L WR^L SUREH^L FDQLEUDWLRQ^L LVXW^L
 + /RZ^L S+^L PHDXUHPQW^L GH^L WR^L D^L SRZH^L RWDJH^L DOG^L DMRFLDWG^L FKPLFD^L SXPS^L V\WHP^L QRM^L
 + (1OXHQ^L SDQDPHWUV^L ZLH^L FROCHW^L DM^L WK^L VOXGJH^L GHZWHULQ^L LQNDW^L GLVFKC^L
 + LJK^L 253^L PHDXUHPQW^L LQ^L PDQKRC^L GH^L WR^L UHFLUXQDWLRQ^L V\WHP^L GRZQNLPH^L
 (1OXHQ^L ROD^L SDQDPHWUV^L ZLH^L FROCHW^L GULQ^L HI OXHQ^L CDQGH^L VRUHQ^L LHSDDU^L
 + ! QIOXHQ^L ROD^L SDQDPHWUV^L ZLH^L FROCHW^L GULQ^L SVSH^L VROLGV^L PDQDJH^L PHQW^L
 + ! QIOXHQ^L S+^L PHDXUHG^L LQ^L WK^L LHOG^L ZDV^L ORZ^L ,QIOXHQ^L S+^L PHDXUHG^L E\ L<sup>WK^L CDRUDW^L L^{ZDV^L +} L^{V◀ X◀ L})LHOG^L SDQDPHWUV^L ZLH^L ROD^L PHDXUHG^L DV^L
 LQIOXHQ^L DOG^L HI OXHQ^L GH^L WR^L WLPH^L FRQWDLQW^L</sup>

SEBUHYLDWLRQ/

+ + + + + CRW^L PHDXUHG^L L<sup>CRW^L UHFRUG^L L^{RUL} ELRUHDFARUL RSHLDWLRQ^L GLG^L
 CRW^L KDM^L 1ORZ^L D^L JLYHQ^L CRZQNLPH^L RQ^L WK^L VSHFL^L LHG^L GDW^L
 JSPL^L + JDDORQV^L SHU^L PLQW^H
 P9^L + PLOOLYROW^L
 253^L + R[LGDWLRQ^L UHGXFLRQ^L SRWQH^L DO
 V◀ X◀ L + WADQDUG^L XQW^L</sup>

3DJH^L ← L RI^L ←

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7\$%/(^L_T
&+\$11(/^L 81'(5'5\$,1^o_L '(1/7\$_L 6((3^o_L \$1'_L +'6_L 75(\$70(17_L 3/\$17_L +_L)/2:_L 5\$7(6
-81(_L₊ !! ^L_¶ →_L 0217+/_L 6800\$5<
^L_{DIM}+_L 3URYLVLRCDDO_L 'DVD

1RWHV

¶◀ L '68 L &8' L DQGL 7UHDWHL :DWHUL 'LVRKDWHL UHFRUGHL ICRZL DUH FDQFXODWHL TURPL ICRZL WRADOL]HU L YROPHL PHDXULPHQWL
±◀ L 7KH L RSHUDALRQDOL ICRZL UDWHL LVL UHSRUWHL :DWHUL GLVFKDWHL GRHV L QRA DOZDVL RFFXUL ± L KRXUL SHUL GD\◀
T◀ L 'LVRKDWHL TURPL WKHL +6 L 7UHDWHL 300QW WRADOL]HU L YROPHL PHDXULPHQWL RQL OD\ L ¶¶ →

\$EEUHYLDWLROV

&8' L + L &KDQHQD L 8QGHUGUDLQ
+ '6 L + L +LJK L HQMLW L 60XGJH

SH9-LT HOWL

JSP^L + L JDORQV^L SHU^L PLQXWH

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 +,*+L ' (16,7<L 6/8'*(* L 75(\$70(17L 3/\$17L + L 23(5\$7,21\$/L '\$7\$L 6800\$5<
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 'UDW L + L 3URYLVLRQDO L 'DWD

5HSRUWLQJ L 3HULRG	7UHDWGL L :DWHU 'LVFKDUJHG ♂ JDOORQV L	/LPH L &RQVXPHG ♂ NLORJUDPV L	'LHMHD L)XHD &RQVXPHG ♂ NLORJUDPV L)ORFFXODQV L &RQVXPHG ♂ NLORJUDPV L	6OXGJH L :DWHG ♂ JDOORQV L)UHMZDWHU L &RQVXPHG ♂ JDOORQV L
\$SULO L ¶ L + L \$SULO L T !! ¶ L + !! ¶ →		!!	!!	¶ Ø T !! ↑	!! ◀ !!	
OD\ L ¶ L + L OD\ L T ¶ Ø L + !! ¶ →		± Ø ¶ !! Ø T → +	¶ ¶ Ø ← + !!	± Ø + !! ←		◀ →
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 +,*+^L '(16,7<^L 6/8'*(^L 75(\$70(17^L 3/\$17^L +^L &203/, \$1&(^L 6\$03/(^L 5(68/76^L
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 'UDM^L +^L 3URYLVLRQDOL' DWD

3DUDPHWHU	%DMLV	OD\ ^L ↑ ↓ + T + '688' → ♪ &KDOQHOL 8QCHLGLDLQ PJ↓ /	OD\ ^L ↑ ↓ + T + '6'6+ 'HOND L 6+HS PJ↓ /	OD\ ^L ↑ ↓ + T + '6,1)→ +'6 ^L , QIOXHQW PJ↓ /	OD\ ^L ↑ ↓ + T + '6())→ +'6 ^L (IIOXHQW PJ↓ /	OD\ ^L ↑ ↓ + T + '6())→ +'6 ^L (IIOXHQW PJ↓ /	OD\ LPXP ^L ♀LVFKDWH ^L &ULWHL ^L ♂ PJ↓ /□	\$YHJDJH ^L 'LVRKDW ^L &ULWHL ^L ♂ PJ↓ /□
S+ ^L ♂ V ^L X ^L □	)LHOG	T ◀↑ T	T ◀ T ←	T ◀← ♪	← ◀ + +	← ◀ T +	+ +	+ +
SOXPLQXP	'LVRQMH	♪	+	♪ +	♪ +	!! ◀	+ +	+ +
SUM-HQI	'LVRQMH	+	!! ◀ !	!! ◀	!! ◀ !	!! ◀ !!	!! ◀ !	!! ◀ !!
&DGPLXP	'LVRQMH	!! ◀ !	!! ◀ !!	!! ◀ !	!! ◀ !! !!	!! ◀ !!	!! ◀ !!	!! ◀ !!
&DCFLXF	'LVRQMH	T +	T T	T +	← +	→	+ +	+ +
&KCRULG	7RNDI	+	+	→ +	+	+	+ +	+ +
&KLURPLXP	'LVRQMH	!! ◀ +	!! ◀ !! !!	!! ◀ ♪	!! ◀ !! !!	!! ◀ !!	!! ◀ !!	!! ◀ !!
&RSSHU	'LVRQMH	!! ◀ !! +	!! ◀ T	!! ◀ +	!! ◀ !! !!	!! ◀ !!	!! ◀ !!	!! ◀ !!
+DUGQHM	'LVRQMH	♪ +	♪ +	♪ +	+	+	+ +	+ +
,UR	'LVRQMH	+	+	+	+	+	+	+
/HDC	'LVRQMH	!! ◀ !! !!	!! !! ◀	!! ◀ !! !!	!! ◀ !! !!	!! !! ◀	!! !!	!! !!
ODJQHMLXP	'LVRQMH				←	← T	+ +	+ +
1LFNH	'LVRQMH	T ◀	!! ◀	T ◀	!! ◀ !	!! ◀ !	!! ◀ !!	!! ◀ !!
6HDHQLXF	7RNDI	!! ◀ !	!! ◀ !	!! ◀ !	!! ◀ !	!! ◀ !!	13	!! ◀ !!
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=LQF	'LVRQMH	!! ◀	!! ◀	!! ◀	!! ◀ !! !!	!! !! .	!! ◀ !!	!! ◀ !!
\$FLGLA	7RNDI	+	+	+	+	+	+ +	+ +
\$ONDOLQW ^L ♂ %LFDE	7RNDI	+	+	+	+	+	+ +	+ +
\$ONDOLQW ^L ♂ &DUE	7RNDI	+	+	+	+	+	+ +	+ +
\$ONDOLQW ^L ♂ +\GLF	7RNDI	+	+	+	+	+	+ +	+ +
\$ONDOLQW ^L ♂	7RNDI	+	+	+	+	+	+ +	+ +
7RNDI 'LVRQMHG ^L !	7RNDI	+ ♪ +	+ ♪ +	+ ♪ -	+ ♪ +	+ ♪ +	+ +	+ +
7RNDI 6XVSQHG ^L 6RQLG ^L	7RNDI	→ !!	↑ → !!	↑ → !!	↑ +	♪ +	♪ + !!	♪ + !!

1RW/H

♪ ◀ S+ YDOXH^L DUH T LHOGL PHDXLHPHQW^L DQG DUH UHSRUW^L LQ^L WADQGDUG^L XQW^L + &RQWALW^L KWDW ZLH^L QRW GHWHFWHG^L DUH OLWNG^L DV^L | | L DQG L WKH^L
 + ◀ L 'LVRKDW^L FUJWHL^L DQG EDMLV^L IRUL PD[L PXP^L DQG DYHJDJH YDOXH^L DUH OLWNG^L UHSRUW^L LQ^L WADQGDUG^L XQW^L RIL ORGL L FWDWLQ^L WR L WKH^L 5HFRYDOL \$FALRQ^L DW^L WKH^L /HYLDWKDQ^L OLQH^L OPRUDQGP^L ♂ 8< 64 L -3\$0 5HFRYDOL \$FALRQ^L DW^L WKH^L RI L DUH L DO L HWALPDW^L YDOXH^L RU L ZLH^L CHW L WKH^L UHSRUW^L LQ^L OLPLW EXW JUHDW^L WKDQ^L RUL HTXDO L WR L WKH^L PHWKRG^L
 GHWHFWHG^L OLPLW
 %L + &RPSRQGZD^L GHWHFWHG^L LQ^L WKH^L EODQN^L DQG LQ^L WKH^L VDPSCH^L
 A^L + ,QWALXPHQW UHDW^L 4& L LV^L RXWLG^L DPHBWDQH^L OLPLW
 PJ↓ / L + PLOOLJUDPV^L SHU^L OLWU
 13 L + 1RW 3URPXQJDW^L

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+, *+L ' (1,67< L 6/8'* (L + L / \$25\$725< L \$1\$ / <7 ,&\$ / L 5(68/76

2) L +'6 L 75(\$70(17 L * (1(5\$7(' L 62/ , '6

-81(L + !! ♪ + L 0217+ / < L 6800\$5<

'UDW + L 3URYLVLRQDO L 'BWD

3DUDPHWHU	OD\ L + ↑ ♪ L + !! ♪ → + + '66/8'* (→ ♪ + &RPSRVWVH %LQ L ♪ L 3LORW &RPSRVWVH				SHUXCDWU\ L 7KUHMROG		
	7RADOL OHADDOV L ♂ PJ↑ NJ	63/3 L ♂ PJ↑ / □	67/& L ♂ PJ↑ / □	7&/3 L ♂ PJ↑ / □	77/& L ♂ SHUXCDWU\ L /LPLWV L IRUL 7RADOL OHADDOV L ♂ PJ↑ ↗	67/& L ♂ SHUXCDWU\ L /LPLWV L ♂ PJ↑ / □	7&/3 L ♂ SHUXCDWU\ L /LPLWV L ♂ PJ↑ / □
\$OXPLOXP	T ♪ ♪	!! ◀ ↑	♪ ♪ |	♪ ♪ ↗	1\$	1\$	1\$
SQALPRQ\	L	L !!	L !!	L !!	↑ !!	¶	1\$
\$UM-HQU	⊥ T	L !!	¶ ◀	L !!	↑ !!	↑	↑
%DULXP	T ▲	L !!	!! ◀	!! ◀ !!	¶ !! ♪	¶ !!	¶ !!
%HJUOOLX	⊥ ▲	L !!	!! ◀	L !! ↗	→	!! ◀	1\$
&DGPLXP	T ▲	L !!	!! ◀	!! ◀ !!	¶ !!	¶	¶
&KURPLXP	†	L !!	⊥ ▲	!! ◀ !!	↑ !! !! L ♂ ↗	↑ L ♂ T	↑
&REDO\	⊥ →	L !!	¶ .	¶ ▲	← ♪ !	←	1\$
&RSSHU	¶ ¶	L !!	† ◀ !	!! ◀ !!	⊥ ♪ !	⊥	1\$
,UR	!! !! !!	L !!	⊥ ♪ !	T ▲	1\$	1\$	1\$
/HDG	L .	L !!	L !!	!! ◀ !!	¶ ♪ !	↑	↑
OHUFXU\	L !! ↗	L !! ◀	!! ◀ !!	L !! ◀	↑	!! ◀	!! ◀
ORO\EGHQXP	L .	L !!	!! ◀ !!	L !!	T ♪ !	T ↑	1\$
1LFN\	† ¶	L !!	T †	◀	⊥ ♪ !	⊥	1\$
6HCHQLXF	L	L !!	L !! ◀	L !!	¶ !!	¶	¶
6LOYF	L .	L !!	L !!	L !!	↑ !!	↑	↑
7KD00LXI	L	L !!	L !!	L !!	→ !!	→	1\$
9DQDGGLXP	T	L !!	!! ◀	L !!	⊥ ♪ !	⊥ .	1\$
=LQF	¶ ↑	L !!	⊥ ▲	!! ◀ ⊥	↑ ♪ !	⊥ ↑	1\$
S+ L ♂ V			→ ◀ !!				
3HUFHQW L ORLW			† ⊥ ◀ ←		8RUURVLYW L FULWHL D L IRUL S+ L L ♪ !	↑ ⊥ ◀ !! L RU	

1RWV

¶ ◀ L 7LWCH L + + + L &DOLIRUQLD L &RGRHRI L 5HUXCDWLRQV\ L 6HFWLRQ L + + + ♪ ◀ + + + ♂ D Q L ♂ + L 6DPSCHV L ZHHL WHWAGL IRU FRQFHQWDLRQV\ L , L WKH L UHMXOW L RI L WKH L 67/& L RUL 77/& L HTXDO L RUL H[PHG L WKHLU L UHSHFWLYH L UHUXCDWU\ L WKUHMROG V\ ZDWKH

± ◀ L &RQFHQWDLRQ L CLPLW L IRUL WRADOL FKURPLXP L DQG L RUL FKURPLXP L ♂ , , , □ L LV L + ♪ ↑ !! !! L PJ↑ / L DQG L CLPLW L IRUL FKURPLXP L

± ◀ L 7KH L IHGHDOL KDJDUGXL V\ ZDWKH L OHYHOL IRUL VROXEH L FKURPLXP L LV L ↑ L PJ↑ / L &DOLIRUQLD L KDV L D L :DWKH L ([MUDWLRL FKURPLXP L ♂ , , , □ L ♂ ↑ + !! L PJ↑ / L DQG L FKURPLXP L ♂ 9, □ L ♂ ↑ L PJ↑ / L & 7R L XVH L WKH L ↑ !! L PJ↑ / L UHUXCDWU\ L WKH L ZDWKH L LV L QRW L D L 5HVRXUPL &RQHJYDNL RQ L 5HFRYHU L \$FW L ♂ 5&5\$ □ L ZDWKH

\$EEUHYL DWLRQ\

| | L L &RQWILW KQWWKDW L ZHHL QRW L GHWHFWGL DUH L OLWAGL DV L | | L WKH L UHSRUW L QJ L CLPLW

- L 5HMXOW L QRWAGL ZLWK L - | L DUH L DQ L HWLWDWGL YDOXH L RUL ZHHL CHW L WKQ L WKH L UHSRUW L QJ L CLPLW EXW JUHDWUL W GHWHFWL RQ L CLPLW

% L L &RPSRQG L ZDVL IRXQG L LQ L WKH L EODQN L DQG L LQ L WKH L VDPSCH

) ¶ L + 06 L DQG L RUL 06' L 5HFRYHU L LV L RWALGH L DFHSWDECH L CLPLW

PJ↑ / L L PLOCJLDPV L SHU L CLWU

PJ↑ NJ L L PLOCJLDPV L SHU L NLQRJDP

1\$ L L 1RW L DSOLFDECH

63/3 L L 6\QKHWLF L 3UHFLSLWDLRQ L /HDFKLQJ L 3URFHGXUH

67/& L L 6ROXEH L 7KUHMROG L /LPLW &RQFHQWDLRQ

7&/3 L L 7R L LFLW &KOLDWVJLWLF L /HDFKLQJ L 3URFHGXUH

77/& L L 7RADOL 7KUHMROG L /LPLW &RQFHQWDLRQ